Diagnosis of Gastrointestinal Disease Using Hypaque Sodium Contrast Medium*†

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WHEN a new diagnostic or therapeutic agent is introduced, it must be clinically evaluated to determine what advantages or disadvantages it possesses in relation to agents already in use for the purpose for which it is proposed.

Recently there was made available to us for study a new gastrointestinal opaque, Hypaque Sodium Powder (brand of diatrizoate sodium, *Winthrop*), which has been found to be endowed with several advantages over conventional barium sulfate in the diagnosis of a number of gastointestinal diseases.[1-10] It possesses no particular advantage over barium sulfate in routine gastrointestinal examinations, but in those instances where the use of barium sulfate is inadvisable or hazardous, it is a most useful agent.

THE MEDIUM

Hypaque is a white crystalline powder which dissolves readily in water or milk giving a true solution. It enters into solution just as readily in an infant's formula. The solution obtained is quite stable. Barium sulfate forms a suspension with its vehicle, the obsorption of this vehicle by the gastointestinal tract has in many instances left hard masses which have caused serious sequelae. Hypaque solution can be made into any desired concentration and is practcally non-toxic. It is well tolerated by patients of all ages. In our present series of 150 cases which form the basis of this report it has been used in infants a few hours after birth and in the aged without signs of toxicity or undesirable side reactions. It does not irritate the peritoneum when it may accidentally enter the cavity. Barium peritonitis and a granulomatous inflammatory reaction have been reported following the accidental entrance of barium sulfate suspensions into the peritoneal cavity. Hypaque solution is rapidly eliminated from the gastrointestinal tract, yet not so rapidly that adequate studies cannot be made even though they are extended through 48 hours. It is slowly absorbed from the peritoneal cavity, sinus tract or closed cavity into which it may accidentally enter or be purposely injected. No allergic reactions have been noted in any of our cases. The medium does not leave solution and form stony masses when retained for extended periods.

DISADVANTAGES

The unpleasant taste of the medium is probably its greatest disadvantage, patient acceptance however in spite of the bitter taste has been uniformly good. Less than 1 per cent of our patients have complained of the taste and no patient, including infants has refused to drink the medium. We do not consider therefore that this mild bitter taste is a major disadvantage. Our attempts to disguise the taste with flavoring agents, flavor coated straws and various sweetened liquid vehicles were only partially successful. Early in our study when oral administration was indicated we used the stomach tube, but frequently encountering major patient resistance to this troublesome and occasionally time consuming procedure we soon discarded it for the simpler method of having the patient drink the medium. There has been no vomiting, but diarrhea has occurred in concentrations between 25 per cent and 40 per cent and invariably in concentrations above 50 per cent. Small bowel mucosal patterns were fuzzy and indistinct. Colon double contrast studies were also unsatisfactory because mucosal coating did not occur. Thin concentrations under compression did however outline colon polyps well.

METHOD OF USE

For oral administration in studies of the upper gastrointestinal tract the powder was dissolved in

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† The Hypaque Sodium Powder (Oral) used in this study was furnished by the Department of Medical Research, Winthrop Laboratories, N. Y.

buttermilk or water in a 25 per cent solution. For infants and small children 12.5 per cent concentration was used, the powder usually being mixed with the child's formula. The 12.5 per cent concentration was also used for lower tract studies in adults (Fig. 1). For those cases requiring injection into sinus tracts, cavities or fistulas concentrations varying from 25 to 50 per cent were used depending on the size of the patient and the diagnostic problem involved.

METHOD OF STUDY

In the examination of the upper gastrointestinal tract, the procedure was carried out in the conventional manner. Pharyngeal and esophageal studies were not as satisfacory as with barium sulfate mixture but gastric mucosal detail was considered better (Fig. 2). The solution mixed readily with blood enabling excellent visualization of bleeding ulcer craters. The medium did occasionally cause pylorospasm which in a few cases required the use of an antispasmodic for relaxation. Pylorospasm occurred more frequently in adults than in children. For small bowel studies oral administration was sufficient in 90 per cent of the cases, in the remaining 10 per cent it was injected through a tube extending into the small intestine. The medium passed rapidly through the intestines and was seen in the ascending colon as early as 60 minutes after oral administration (Figs. 3 and 4). This accelerated transit time is particularly desirable in studies for intestinal obstruction. Constricted, dilated and obstructed segments of bowel were well demonstrated.

For enema studies, the density of the 12.5 per cent solution was quite adequate (Fig. 1). The medium proved satisfactory for single contrast studies, however, since mucosal coating did not occur it is not advised for double contrast examinations. No difficulty was encountered when injected into colostomy openings, sinus tracts, fistulas or closed cavities. There was no immediate or delayed reaction due to the medium and when prompt drainage did not occur, the medium was eventually absorbed.

CLINICAL APPLICATIONS

Intestinal Obstruction. One of the most informative applications of this new medium is in the diagnosis of intestinal obstruction (Flg. 5). This is particularly true in the case of mechanical ileus associated with a complicating paralytic ileus or when the survey films are negative. Obstructed bowel distended with fluid may show no evidence of the obstruction on the plain radiograph, early obstruction may only give equivocal and confusing survey radiographic information. The oral administration of the medium and serial films may not only provide a diagnosis in as early as 30 minutes but frequently pin points the location of the obstruction as well (Figs. 6 and 7). The medium was particularly useful in post operative cases with abdominal distension due to paralytic ileus. It is frequently difficult to differentiate these cases from a mechanical ileus. Despite the apparent lack of peristalsis, in our experience once the Hypaque solution enters the small bowel it moves progressively and rapidly caudad until it has traversed the entire bowel unless arrested by a mechanical obstruction.

In mechanical obstruction of the colon due to an annular constricting lesion, or a large mass we prefer Hypaque solution to the barium sulfate suspension. With barium mixtures there is the ever present possibility of barium trapped proximal to the constriction, becoming inspissated and changing a partial to a complete obstruction. (Figs. 8 and 10). In complete colonic obstruction, oral administration of 50 per cent Hypaque solution in conjunction with a 12.5 per cent Hypaque

Fig. 1. Solution of 12.5 per cent provide satisfactory density for colon examinations.

Fig. 2. Gastric rugal detail is quite satisfactory.

Fig. 3. Rapid transit time. Medium in colon in 60 minutes. Small bowel well filled.

Fig. 4. Rapid transit time. Medium in rectum at 6-hour examination.

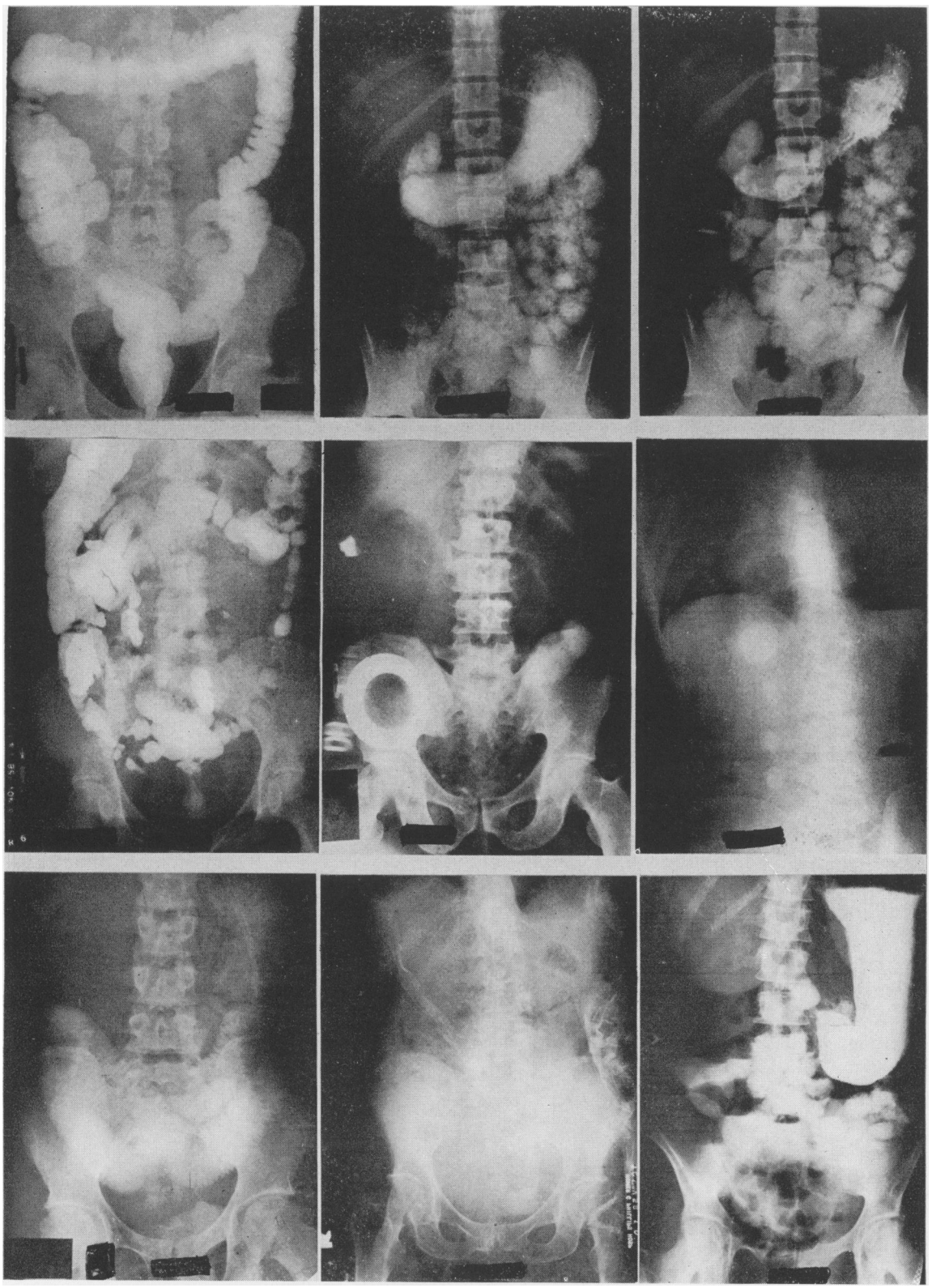
Fig. 5. 59-year-old male with a total cystectomy for carcinoma of the urinary bladder and ileal pouch. Clinical signs of mechanical ileus. Medium arrested in left iliac region by an obstructing mass of adhesions.

Fig. 6. Solitary fluid level suggesting mechanical intestinal obstruction.

Fig. 7. Mechanical obstruction of ileum due to an adhesive band. Point of obstruction well demonstrated.

Fig. 8. No rentention of medium proximal to constricting rectal lesions.

Fig. 9. Dilated loops of ileum with fluid levels due to mechanical obstruction. Note excellent gastric density.



First Row—Figs. 1-2-3 *Second Row*—Figs. 4-5-6 *Third Row*—Figs. 7-8-9

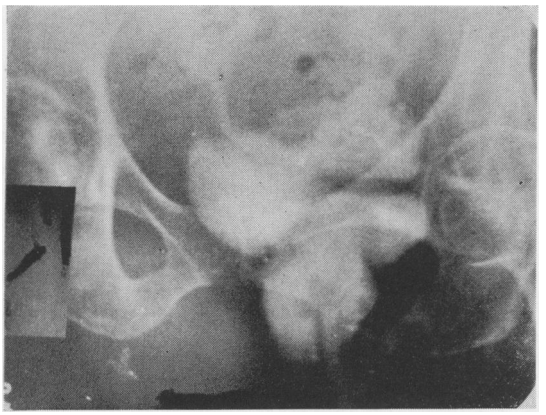


Fig. 10. Rectal mass causing almost complete obstruction.

enema six to 12 hours later enables a study of the colon both proximal and distal to the obstruction.

Partial obstruction can be readily differentiated from complete by serial studies, noting the progress of the medium as it passes through the intestines, observing carefully for temporary arrests of the head of the column and dilated loops of bowel (Figs. 9, 11, 12, 13, 14). Another useful application was in the case of a pregnant woman whose persistent vomiting was first thought to be due to hyperemesis gravidarum, fortunately serial Hypaque small bowel studies revealed a mechanical intestinal obstruction involving the terminal ileum.

Gastrointestinal Rupture. In suspected rupture or perforation of the gastrointestinal tract such as spontaneous rupture of the esophagus, rupture of a peptic ulcer or diverticulum or perforation due to gunshot, stab or accidental injuries, Hypaque solution provides an ideal medium with which to demonstrate the abnormal communication when present and which does not cause either connective tissue or peritoneal reaction when it escapes from the gastrointestinal tract. In the absence of positive x-ray findings and rupture of peptic ulcer or diverticulum is suspected, Hypaque solution because of its non-irritating properties can be used without fear of complicating an already serious condition (Figs. 15 and 16). Large volume requirements and prolonged retention preclude the use of opaque oils and the possibility of barium peritonitis or granuloma formation contraindicate the use of barium sulfate. The Hypaque solution is eventually abosorbed.

Bleeding Peptic Ulcers. Hypaque solution mixes readily with blood and for this reason has been found to possess definite advantages in the study of bleeding peptic ulcers. It is highly advisable in attempting to locate the source of gastrointestinal hemorrhage to use a medium which will not cause peritonitis or granuloma formation in the event of accidental perforation of a peptic ulcer. Both bleeding gastric and duodenal ulcers have been readily demonstrated using Hypaque solution and Hampton technic (Figs. 17 and 18).

Internal Fistulas. The demonstration of internal fistulas and sinus tracts is difficult under optimum conditions. The selection of an opaque medium for this purpose poses a problem especially when large amounts must be used. Aqueous Hypaque solution also appears to enter the smallest opening with greater facility than oily mediums or thick suspensions of other opaques. We have used Hypaque successfully in tracheoesophageal fistulas and in the demonstration of intra-abdominal fistulas and sinuses. An example is the case of a 34 year old female patient who developed a fecal fistula ten days post operatively. She also showed signs of peritoneal irritation. It could not be determined clinically whether the fistula communicated with the large or small bowel. Attempts at external injection was unsuccessful. A retrograde colon Hypaque enema with reflux into the ileum readily demonstrated communication between the terminal ileum and the exterior. There was no leakage into the peritoneal cavity.

Fig. 11. Medium in colon at 2-hour examination. Obstruction was partial.

Fig. 12. 51-year-old female who had had 8 abdominal operations for mechanical intestinal obstruction. Distended segment of ileum in left iliac region. Residual medium from enema in colon.

Fig. 13. Loop of ileum still distended at 4 hours but additional medium is seen distal to the obstruction.

Fig. 14. Obstruction of ileum partial. Majority of medium evacuated at 24-hour examination.

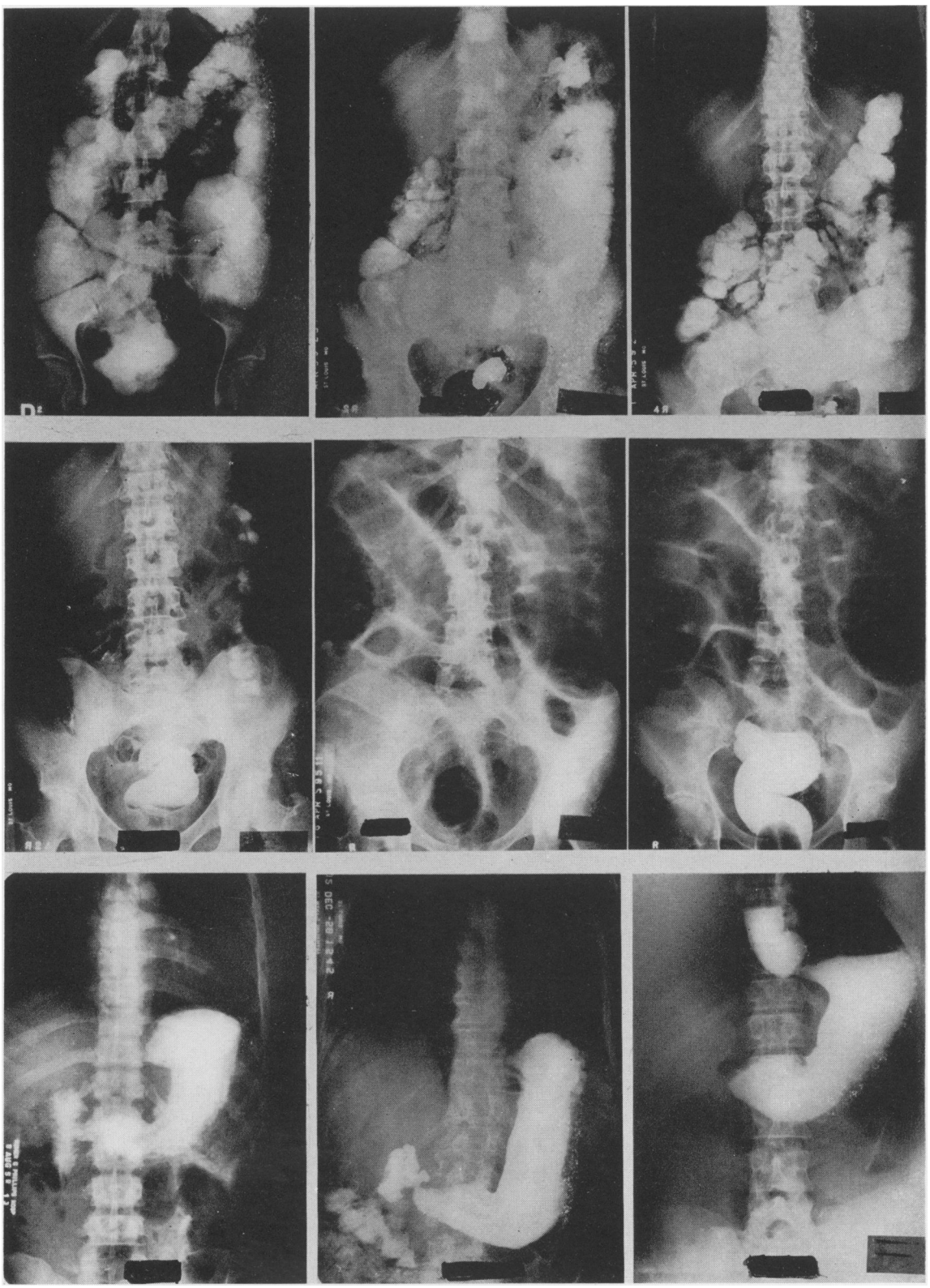
Fig. 15. Peritonitis and mechanical obstruction of colon with possible perforation.

Fig. 16. Complete obstruction at recto-sigmoid juncture but no evidence of perforation.

Fig. 17. Crater of bleeding ulcer readily demonstrated on lesser curvature of stomach.

Fig. 18. Giant bleeding perfo rating duodenal ulcer.

Fig. 19. Pyloric obstruction due to acute pancreatitis. There is an associated cardiospasm.



First Row—Figs. 11-12-13 *Second Row*—Figs. 14-15-16 *Third Row*—Figs. 17-18-19

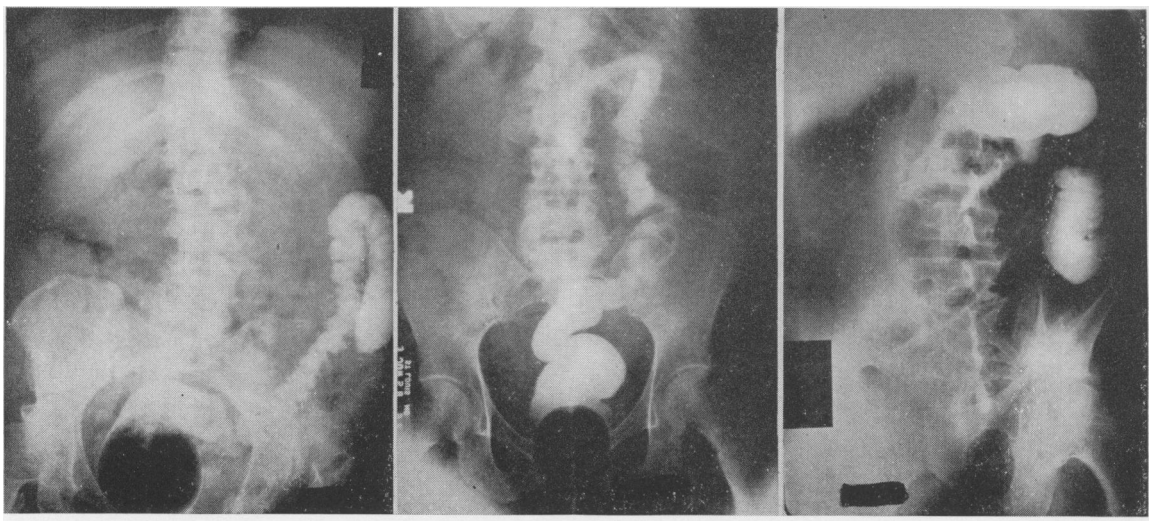


Fig. 20 Fig. 21 Fig. 22

Fig. 20. Demonstration of a satisfactory end to end colon anastomosis before closure of colostomy.

Fig. 21. Narrow constriction of end to end anastomosis at junction of descending colon and sigmoid.

Fig. 22. Total colectomy. Suspect obstruction and leaking at junction of ileum and rectum. Medium injected into colostomy.

Pyloric Obstruction. Hypaque solution has no superiority over other opaques in the study of pyloric obstruction, in fact, in a small percentage of cases there is a tendency to cause pylorospasm, which however can be readily controlled by the administration of an antispasmodic. When there is prolonged gastric retention which persists in spite of appropriate medication, pyloric obstruction rather than pylorospasm is almost certain to be present (Fig. 19).

Investigation of Intestinal Anastomoses. Another effective application is in the examination of intestinal anastomoses following surgery (Fig. 20). The patency of the union when stricture (Fig. 21) or obstruction (Figs. 22 and 23) is suspected can be readily determined and if leaking is present Hypaque solution can be used without fear of additional peritoneal irritation by the medium. In an obstructed large bowel anastomosis with a colostomy injection of the medium through the colostomy stoma combined with an enema will permit study of the bowel distal and proximal to the obstruction. The medium is retained by rentention bulbs.

Constriction of the Colon. One hesitates to use barium sulfate suspension in constricting lesions of the colon because of the chance of trapping the medium proximal to the constriction and the creation of a complete mechanical obstruction by rock-like masses of inspissated barium. This hazard does not exist when Hypaque solution is used. Another observation in these cases is that the Hypaque solution traversed constricted channels which appeared impervious to the barium suspension.

In Hirschsprung's disease the application is similar to that of other constricting lesions of the colon. With the use of the Hypaque solution the possibility of inspissated medium retained proximal to the spastic segment of bowel is eliminated.

Visualization of Sinus Tracts. Satisfactory employment of the medium has been made in the visualization of sinus tracts. Its non-irritating properties and slow but eventual complete absorption and excretion make it ideal for this purpose. It is excreted rapidly enough to permit other diagnostic studies requiring the use of opaques without undue delay. When a large amount of an opaque is required and a barium sulfate suspension is contraindicated, the use of opaque oil would be prohibitive. One useful large volume application is the demonstration of blind sinus tracts communicating with the rectum. The number, size, direction and extent of these sinuses can frequently be shown using a Foley type catheter to obstruct the colon proximal and distal to the ostia of the

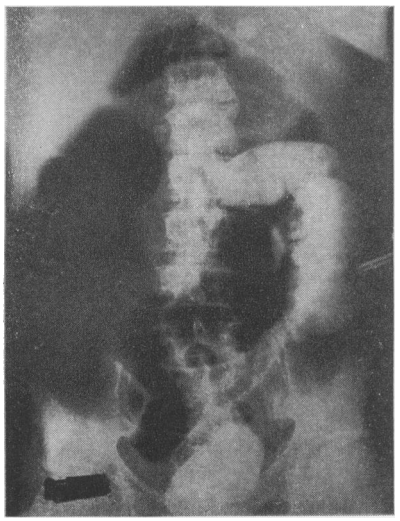


Fig. 23. Medium in rectum. No evidence of obstruction or extravasation.

suspected sinuses and injecting the medium under moderate pressure into the segement of bowel between the catheters.

These sinuses can be filled without fear of prolonged retention of the medium. Diverticulae of both the small and large bowel can be demonstrated by either oral or rectal administration as indicated. In those cases where perforation has occurred or is suspected and the referring surgeon requests additional information before operating, Hypaque solution is the preferred medium.

Study of Abscess Cavities. The injection of 25 per cent Hypaque solution into subdiaphragmatic and other similar intra-abdominal cavities after drainage has been established provides information regarding the size, shape, number, location and communication of the cavities. This type examination may require large amounts of medium. Obviously barium sulfate suspension could not be used for this application and large volumes of opaque oil would be prohibitively expensive. When oil is used should drainage be inadequate, it would remain in the pocket indefinitely.

For complete patient recovery all abscess pockets must be drained. In one of our cases of subdiaphragmatic abscess complicating a ruptured peptic ulcer, such a study revealed that prolonged patient morbidity in spite of what was considered adequate drainage was due to multiple abscess cavities containing air fluid levels which did not communicate with the cavity being drained.

Identification of Viscera. In the identification of viscera in hernial sacs, in the thorax in cases of diaphragmatic rupture or large hiatus hernia and in the rare case of the differentiation between a pneumothorax and a gas distended intrathoracic stomach, Hypaque solution possesses no advantage over a thin barium mixture unless damage to the viscus is suspected.

In anomalies of the gastrointestinal tract, especially those which have resulted in the development of blind pouches in which non-absorbable medium may be trapped, Hypaque solution is the medium of choice. We have not had the opportunity to use it in the study of a case of imperforate anus but it should find an informative application in this anomaly.

Location of Foreign Bodies. In pin-pointing the location of opaque foreign bodies in the gastrointestinal tract especially when arrested, rapid serial studies with the thin 12.5 per cent concentration by oral or rectal administration readily identifies the portion of the bowel in which the body may be fixed. In the case of sharp pointed objects such as pins or needles where perforation may be suspected it would not be advisable to use an irritating non-absorbable medium. An additional reason for not using barium suspension to locate these bodies is that barium density frequently obscures the object. The thin Hypaque solution was also very useful in detecting the location and presence of non-opaque masses such as polyps of the colon. It is essential that compression and spot filming be used in these instances.

CONCLUSION

Hypaque aqueous solution is a new gastrointestinal opaque which has many useful, informative clinical applications. It can be used in all instances where barium sulfate suspension is indicated and has many applications where the use of barium sulfate is inadvisable or hazardous.

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NATIONAL FOUNDATION SCHOLARSHIP PROGRAM

Nearly 1,100 young people seeking to enter medical schools in September 1959, applied for one of the 103 medical student scholarships offered by The National Foundation under its recently announced Health Scholarship program. More than 4,600 applications were received from students seeking financial assistance to enter the health field. In addition to students seeking help to enter medical schools, approximately 2,500 sought to enter schools of nursing, 500 to enter physical therapy, 200 to enter medical social work, and 300 to enter schools of occupational therapy.

Successful applicants in each state were chosen by special Health Scholarship Selection Committees composed of representatives of the five health professions concerned. State medical societies cooperated in nominating doctors who would represent their specific discipline.

Winners of the awards were notified early in August by the chairman of the local National Foundation chapter in the area in which the student lives.

The health scholarships, which provide $2,000 for four years of college education for each recipient, are a part of the total expanded program of The National Foundation, the objectives of which are: to extend the frontiers of research and patient aid developed in the conquest of poliomyelitis, to other disabling diseases. After years of study and planning, The National Foundation selected arthritis and congenital malformations of the central nervous system as the logical first steps to accomplish these goals.

Through scholarship assistance to over five hundred young people annually, The National Foundation will add to the total number of professional persons in the nation and, through continued support for graduate and post-doctoral study, will assist in the preparation of additional research scientists, teachers, and clinical specialists so necessary to the attainment of any health objective.

The National Foundation Health Scholarship program is supported by the New March of Dimes.

FALLS A MAJOR CAUSE OF DEATH

Accidental falls are a major cause of mortality in the United States, accounting for more than 20,000 deaths — a death rate of 12 per 100,000 population — each year, according to statisticians of the Metropolitan Life Insurance Company. The loss of life resulting from falls is more than three times that caused by fires and explosions, nearly 10 times that from accidents involving firearms, and about 15 times the toll from aircraft accidents. Most of the victims of fatal falls are older people. The death rate from falls decreases moderately from infancy to a minimum at the school ages and then rises progressively with advance in age, slowly at first but sharply at the older ages. Under age 75 the death rate is higher for males than for females, but thereafter the rates are sharply reversed. Somewhat more than half the people fatally injured in falls — about 11,000 a year — suffer their injuries in and about the home, reflecting the high frequency of falls among older people, who generally spend a major part of their time at home. Only 2 per cent of fatal falls — little more than 400 a year — results from accidents in factories, mines and quarries, and other industrial places.

Nearly nine tenths of the people reported as fatally injured in falls on the same level are 65 years of age and older. Quite commonly these people fall while merely walking about the house; in many instances physical weakness or impairment is a contributory factor.